

Europäisches Patentamt

European Patent Office

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(11)

**EP 0 840 032 A2**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
06.05.1998 Bulletin 1998/19

(51) Int. Cl.<sup>6</sup>: **F16F 7/09**, F16F 11/00

(21) Application number: 98100585.3

(22) Date of filing: 16.12.1992

(84) Designated Contracting States:  
AT DE FR GB IT SE

(30) Priority: 20.12.1991 US 811758

(62) Document number(s) of the earlier application(s) in  
accordance with Art. 76 EPC:  
93902698.5 / 0 617 771

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Remarks:

This application was filed on 15 - 01 - 1998 as a  
divisional application to the application mentioned  
under INID code 62.

(54) **Process for increasing the wearlife or surface effect dampers**

(57) A dual-rate surface effect damper (10) with extended useful life. The dual rate is provided by two cylindrical liners (32,34) which have different inner diameters which engage a damping piston (12) having protrusions which have an interference fit with the liner (32,34). Features which extended life include heat dissipative elements such as internal (14) and external (24) fins, a convective heat transfer path for cooling air through the piston and a lubricant of MoS<sub>2</sub> dispersed in a Teflon®-filled fluorsilicone. Maintaining the temperature of the elastomer below about 200°F (93.3°C) is critical to avoiding thermal breakdown. In addition, the elastomer and metallic surfaces can undergo a surface treatment to reduce their tendency to abrade and to cause abrasion, respectively.

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Printed by Janssen, 11th, European Patent Office

## Description

### Field of the Invention

The present invention relates to improvements in dampers. More specifically, this invention is directed to dampers which create forces having both a hysteretic component and a friction component identified herein as surface effect dampers.

### Background and Summary of the Invention

One of the earliest patents relating to dampers employing hysteresis damping, that is the dissipation of translational energy by working of an elastomeric member, is U.S. patent no. 3,232,597 to Gaydecki. As a way of achieving a practical wearlife for his damper, Gaydecki sought to eliminate or, at least, minimize the frictional force component developed between the elements of his damper.

As described in the aboveidentified related application, eliminating totally the friction component of damping places severe limits upon the damper's design because a significant potential damping force has been eliminated. The approach taken in the aforementioned application and by Applicants herein, is to take advantage of the damping force available while minimizing the damage friction can produce.

For certain applications, it is desirable to produce one level of damping under certain circumstances and a second level of damping under other circumstances. One such application is in the area of railcar dampers. It is desirable to produce different levels of damping force for filled railcars than for empty ones. An increased damping force will be necessary to control the movement of the loaded railcars.

A device similar to that described herein is shown in published European patent application 0217234 A1. That application discloses a housing 4 which tapers down at its distal end to afford a braking force to the piston 5.

In one aspect, this invention provides a dual-rate surface effect damper assembly producing a damping force having a hysteretic component and a friction component, said damper including a housing, a rubbee member mounted for relative movement with respect to said housing, a first elastomeric liner section having a first length with a first uniform inner diameter for engagement by said rubbee to produce a first uniform surface effect damping force, a second elastomeric liner section having a second length, said dual-rate surface effect damper being characterized by said second elastomeric liner section having a second smaller uniform inner diameter for engagement by said rubbee to produce a second larger uniform surface effect damping force.

It is an important aspect of the present invention to control the potentially damaging characteristics of the

friction damping force component of the surface effect damper. Several elements are provided to permit this control.

First, heat dissipative fins are provided on the external periphery of the housing as is suggested in the contemporaneously filed patent application.

Second, cooling is provided internally to the rubbee piston by creating air flow to dissipate heat.

Third, an abrasion resistant elastomer is selected for each of the liner segments, in accordance with the teachings of the companion application.

Fourth, the external surface of the rubbee piston is coated with a material to diminish its porosity and, hence, its abrasion producing proclivities.

Finally, a lubricant is introduced between the rubber member and the rubbee member to control the magnitude of the friction component. A lubricant which has been shown to have particularly useful properties in extending the wearlife of the elastomer is a (fluoro)silicone lubricant which is filled with Teflon® particles and has dispersed therein molybdenum disulfide ( $\text{MoS}_2$ ). The ratio of filled silicone grease to  $\text{MoS}_2$  which appears optimum is on the order of 15 to 1, by weight.

From another aspect the invention consists in a process for increasing wearlife of an elastomeric damper element in a damper assembly as described above, wherein said elastomeric damper element is subject to abrasion by a rubbee member, said process includes the steps of equipping some portion of said damper assembly with heat dissipative elements; surface treating said rubbee member to decrease its tendency to abrade said elastomeric damper element; lubricating a surface portion of said damper element with a silicone grease, in which is dispersed a small amount of molybdenum disulfide, in order to effectively control any heat buildup in said damper assembly and maintain a temperature of said elastomeric damper element below a particular critical temperature above which thermal breakdown of said elastomeric damping element occurs.

Various other features, advantages and characteristics of the present invention will become apparent after a reading of the following invention.

### Brief Description of the Drawings

FIG. 1 is a cross-sectional side view of a preferred embodiment of the damper of the present invention;

FIG. 2 is an enlargement of a portion of the housing shown in Fig. 1 showing the transition region;

FIG. 3 is a cross-sectional side view of a rubbee of a second embodiment of the present invention;

FIG. 4 is an end cross-sectional view taken along line 4-4 in Fig. 3; and

FIG. 5 is a cross-sectional side view of the rubbee of yet a third embodiment.

#### Detailed Description of the Preferred Embodiments

A first preferred embodiment of the surface effect damper assembly of the present invention is shown generally at 10 in Fig. 1. Damper 10 has two principal components: a piston 12 and a housing 20. One end of piston 12, which is preferably made of a heat conductive metal such as aluminum or an aluminum alloy, has a plurality of annular protrusions 14. Protrusions 14 are identified as the "rubbee" member of the surface effect damper 10 (they effect the working of the elastomer that results in hysteresis damping). In a surface effect device of the type discussed here, the protrusions 14 of the rubbee also create the frictional component of the damping force by interacting with the rubber element.

A second end of piston 12 is provided with attachment bushing 16 by which damper assembly 10 can be attached to a first member (not shown). In one possible usage of damper 10, bushing 16 is attached to the undercarriage of a railcar (not shown). Piston 12 is preferably thin walled and hollow for optimum heat dissipation. Various other configurations that can further optimize heat dissipation are described with reference to other embodiments.

Housing 20 also has a bushing 22 on the end opposing the piston 12 for connection to a second member (not shown). In the railcar application, the bushing 22 is connected to the railcar. The external surface of housing 20, which is also preferably of aluminum alloy, is equipped with a plurality of annular heat-dissipating fins 24. First end plate 26 is attached by bolts 28 as is second end plate 27. First end plate is preferably of the same heat-dissipative aluminum alloy of which the cylindrical portion of housing 20 is made. Second end plate 27 may similarly be made principally of aluminum alloy but may be provided with a Teflon® bushing (not shown) to receive piston 12.

Housing 20 has a liner 30 bonded to its internal cylindrical periphery. As best seen in Fig. 2, liner 30 has a stepped configuration. A first elastomeric liner section 32 has a first length having a first substantially uniform inner diameter which is smaller than the outside diameter of protrusions 14 to provide a first level of surface effect damping force. In the railcar application, this level of damping corresponds to the empty railcar usage. A second elastomeric liner section 34 having a second length with a second smaller internal diameter is provided to produce a second higher level of surface effect damping force. In the rail car application, this level of damping will correspond to the fully loaded railcar where greater levels of damping are needed to control the increased load. A third liner segment 36 forms a transition section between the two damping levels afforded by sections 32 and 34. Preferably, the maximum internal dimension of transition section 36 corre-

sponds to the ID of section 32 and found at the lower edge of section 36 (as seen in Fig. 2). The minimum internal dimension of third liner segment 36 corresponds to the ID of section 34 and is found at the uppermost edge of section 36.

The elastomer is selected for a plurality of properties including surface toughness, abrasion resistance, high hysteresis, absence of low temperature stiffness, and stability at temperatures exceeding 200°F (93.3°C). Exemplary of elastomers suitable for this application are blends of natural rubber and styrene butadiene and natural rubber and castable urethanes. It will be apparent that one way to vary the damping properties of sections 32 and 34 would be to vary the properties of the sections by using different elastomers.

Another way to optimize the wearlife of the elastomer is to minimize the amount of abrasion between rubbee 14 and rubber liner 30. This can be accomplished by "polishing" the surfaces of both the elastomer of liner 30 and the metal of rubbee 14. The specifications for the surface finish of the rubber calls for a surface finish of 32 microinches. A similar surface finish is called for on the metal member if a lubricant coating is to be applied such as a Teflon® coating. One suitable coating, a resin bonded fluoropolymer is sold under the tradename "Emralon 333" by Acheson Colloids. A surface finish of 16 microinches for the metal part is specified if coating is not contemplated.

A most important aspect for controlling the level of frictional damping force and resultant heat developed, is through the use of a suitable lubricant. A number of lubricants have been tried and one that is particularly suitable is a fluoro silicone grease filled with Teflon® particles in which is dispersed 15:1 by weight molybdenum disulfide (MoS<sub>2</sub>). Suitable filled greases include FS3452 and FS1265 available from Dow Corning. Another suitable carrier for the MoS<sub>2</sub> is a silicone fluid available from Mobay Chemical having a viscosity of 300K centistokes. Where other lubricants were allowing the friction to cause elastomer deterioration after 120K-150K cycles, this family of lubricants containing molydisulfide extended wearlife to between 400K and 600K cycles. In one set of tests in which the lubricant was combined with the surface coating of the piston mentioned above, 2000K cycles produced no evidence of elastomer wear, while the damper produced an average damping force of 800 pounds.

These tests indicate the importance of keeping the elastomer temperature below a critical deterioration temperature which is somewhat above 200°F. By establishing a design criterion of 200°F as the maximum temperature the damper assembly 10 is allowed to see, the elastomer is prevented from reaching its thermal breakdown temperature. Accordingly, a second (Figs. 3 and 4) and third (Fig. 5) embodiment have been developed to ensure that this critical temperature is not reached.

As seen in Figs. 3 and 4, piston 12 having protrusions 14 has a convection enhancing insert 38 pressfit

into the open end 15. As best seen in Fig. 4, a plurality of axial bores 40 drilled through insert 38 create a plurality of heat dissipating surfaces or fins 42. Two air inlet ports 44 are provided in the base of piston 12 and two exit ports (not shown) are provided in the end of housing 20 opposite piston 12. Insert 38 will serve as a heat sink and air flow through axial bores 40 past fins 42 will enhance conductive and convective heat transfer with the heated air leaving the top of housing 20.

The Fig. 3 embodiment is effective at removing heat. However, for certain applications where unfiltered ambient air may be dust laden, this solution to heat buildup introduces secondary problems. The dust carried into housing 20 will adhere to the lubricant-coated elastomeric liner 30 and cause abrasion. One way to avoid such a problem would be to connect an elastomeric bellows between the end of piston 12 and housing 20 to define an airflow passage which does not include liner 30. Another solution to this problem is depicted in Fig. 5.

The third embodiment of the piston 12 of the damper of the present invention is shown in Fig. 5. In this embodiment, piston 12 is made in two sections 11 and 13 which can be joined as by welding. Sections 11 and 13 facilitate the attachment of baffle 46 within section 13 and a plurality of ribbon-like fins 42 whose ends may be pinched between housing sections 11 and 13. These fins 42 extend only a fraction of the width of housing 20 such that air entering inlet port 44 can freely circulate about fins 42 to accomplish the convective heat transfer. Preferably, inlet port 44 extends in the forward direction such that, when the railcar or other such vehicle is in motion, air will be forced into inlet port 44 as in a ram jet, circulate around baffle 46 past fins 42 and convey the heat out exit port 45. Since the airstream never enters the housing 20, the elastomer of liner 30 is not exposed to any dust it may carry.

It can be appreciated that the present invention comprises an improved surface effect damper 10 which is capable of developing two distinct levels of damping as conditions warrant. While the device has been described as potentially useful in a railcar application, it will be appreciated that damper 10 can be substituted for shock absorbers in other vehicles or non-vehicular applications, as well. Further, this invention presents several features (external and internal fins, convective heat transfer path, specific lubricant, surface treatments) which extend the wearlife of the damper and make the device practical for use.

Various changes, alternatives and modifications will become apparent to one of ordinary skill in the art following a reading of the foregoing specification. It is intended that all such changes, alternatives and modifications as fall within the scope of the appended claims be considered part of the present invention.

## Claims

1. A process for increasing the wearlife of an elastomeric damper element (30) in a damper assembly (10), wherein said elastomeric element (30) is subject to abrasion by a rubbee member (12), said process comprising:
  - a) equipping some portion of said damper assembly (30) with heat dissipative elements (24, 42, etc.);
  - b) surface treating said rubbee member (12) to decrease its tendency to abrade said elastomeric damper element (30);
  - c) lubricating a surface portion of said damper element (30) with a silicone grease, in which is dispersed a small amount of molybdenum disulfide, in order to effectively control any heat buildup in said damper assembly (10) and maintain a temperature of said elastomeric damper element (30) below a particular critical temperature above which thermal breakdown of said elastomeric damping element (30) occurs.
2. The process of Claim 1 further characterized by a fluoro silicone grease.
3. The process of Claim 1 further characterized by said grease being filled with Teflon particles.
4. The process of Claim 1 further characterized by a weight ratio of grease to dispersed molybdenum disulfide of 15:1.
5. The process of Claim 1 further characterized in that the step of maintaining the temperature of said elastomeric damping element (30) below a critical temperature comprises the step of maintaining said damping element (30) temperature below 200°F (93.3°C).
6. The process of Claim 1 further characterized in that the step of surface treating includes forming a highly polished lubricious surface finish on said rubbee member (12) which minimizes friction-induced abrasion.
7. The process of Claim 1 further characterized in that the step of surface treating includes the step of coating said rubbee member (12) with a highly lubricious coating.
8. The process of Claim 7 further characterized by said coating being a Teflon resin.

9. The process of Claim 1 further characterized by said heat dissipative elements including at least one fin (42 etc.) within said rubber member (12) for conductive and convective heat transfer.

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10. The process of Claim 1 further characterized by said heat dissipative elements including a plurality of heat dissipative fins (24) on an external surface of a damper housing (20).

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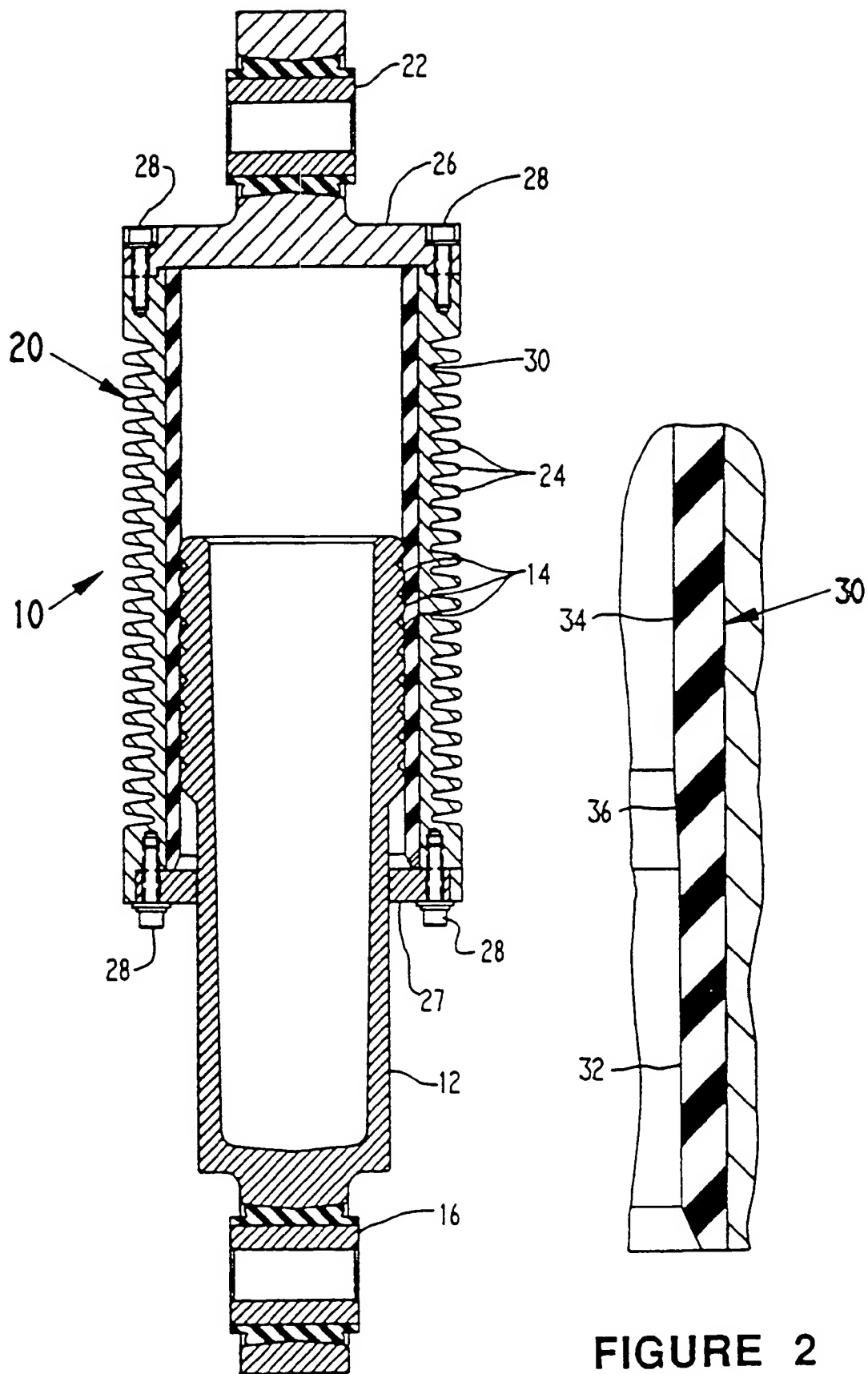


FIGURE 1

FIGURE 2

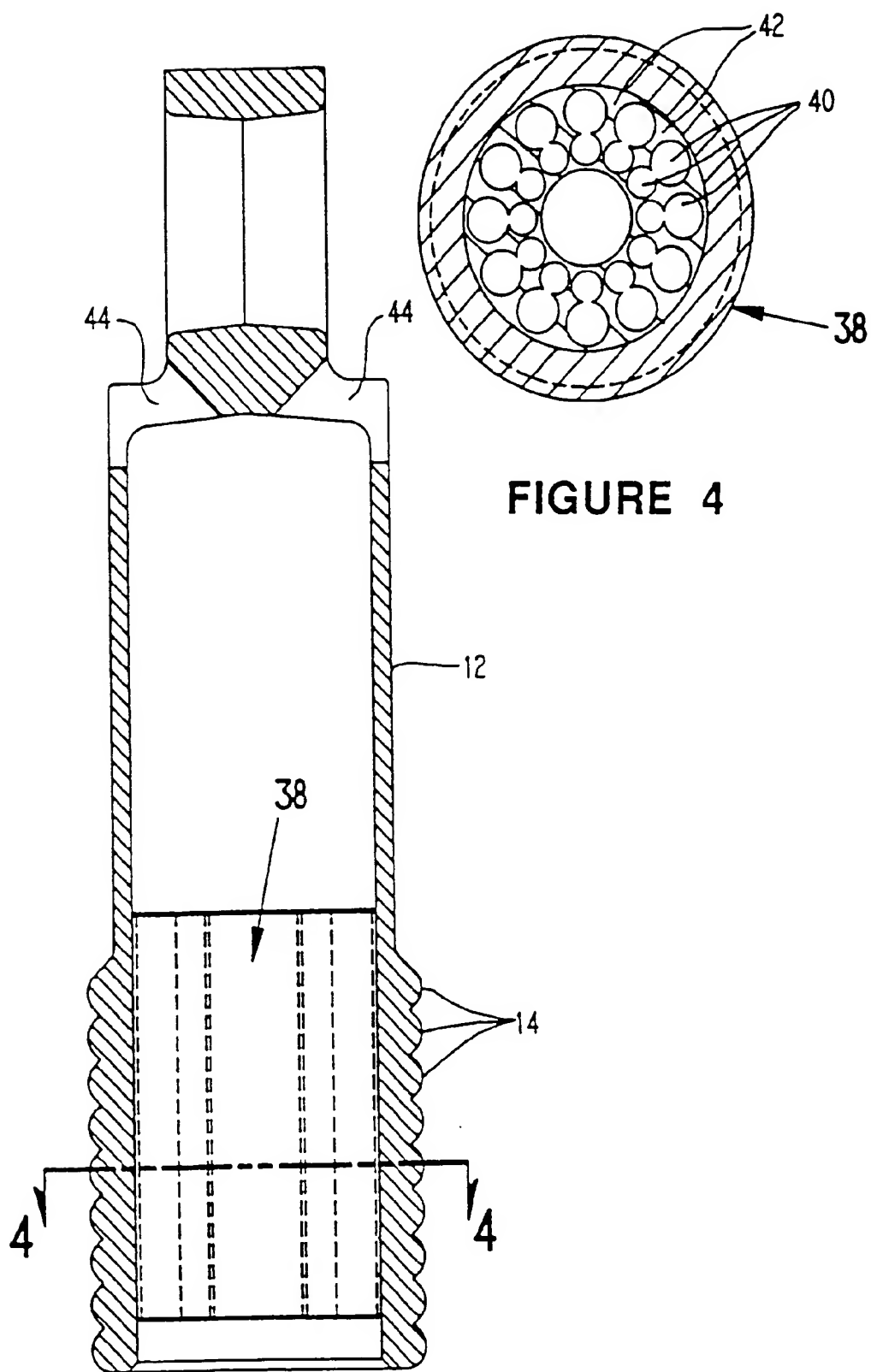


FIGURE 4

FIGURE 3

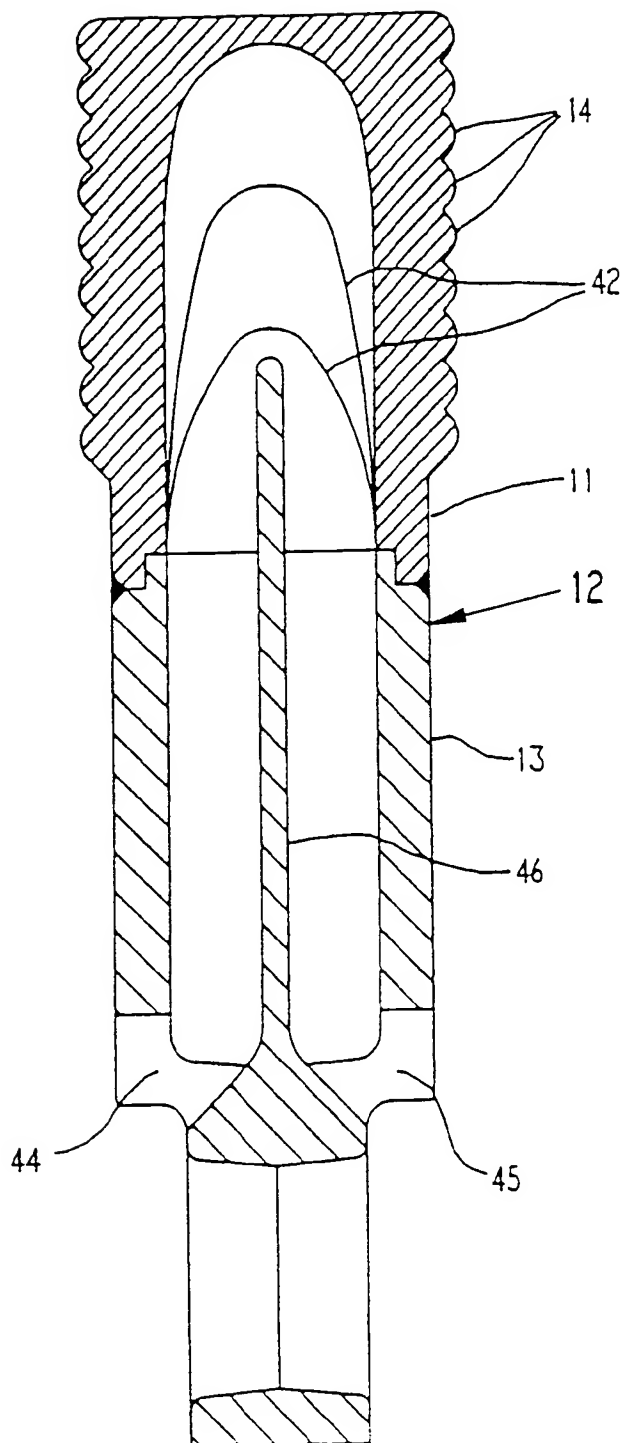
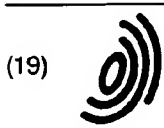


FIGURE 5



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EP 0 840 032 A3

(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
22.07.1998 Bulletin 1998/30

(51) Int. Cl.<sup>6</sup>: F16F 7/09, F16F 11/00

(43) Date of publication A2:  
06.05.1998 Bulletin 1998/19

(21) Application number: 98100585.3

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### (54) Process for increasing the wearlife or surface effect dampers

(57) A dual-rate surface effect damper (10) with extended useful life. The dual rate is provided by two cylindrical liners (32,34) which have different inner diameters which engage a damping piston (12) having protrusions which have an interference fit with the liner (32,34). Features which extended life include heat dissipative elements such as internal (14) and external (24) fins, a convective heat transfer path for cooling air through the piston and a lubricant of MoS<sub>2</sub> dispersed in a Teflon<sup>®</sup>-filled fluoroelastomer. Maintaining the temperature of the elastomer below about 200°F (93.3°C) is critical to avoiding thermal breakdown. In addition, the elastomer and metallic surfaces can undergo a surface treatment to reduce their tendency to abrade and to cause abrasion, respectively.

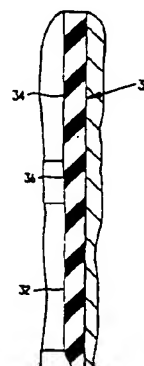


FIGURE 2

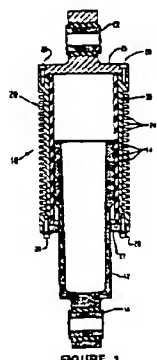


FIGURE 1

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# EUROPEAN SEARCH REPORT

Application Number  
EP 98 10 0585

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D, Y	US 3 232 597 A (J. GAYDECKI) 1 February 1966 * the whole document *	1, 6, 7, 9	F16F7/09 F16F11/00
A	* column 5, line 30 - line 38 * * column 5, line 52 - line 70 * ---	8	
Y	US 4 934 493 A (BAUER HANS J ET AL) 19 June 1990 * column 2, line 34 - line 54 * * column 4, line 42 - line 53 * * the whole document *	1, 6, 7, 9	
A	US 3 990 542 A (DENT ROBERT K ET AL) 9 November 1976 * the whole document * * column 4, line 53 - line 61 * ---	1, 8	
A	US 4 946 008 A (BAUER HANS-PETER ET AL) 7 August 1990 * abstract; claims; figures * ---	1	
E	US 5 183 137 A (SIWEK C KENNETH ET AL) 2 February 1993 * the whole document * -----	1-10	<div>TECHNICAL FIELDS SEARCHED (Int.Cl.6)</div> <div>F16F</div>
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 May 1998	Examiner Van der Veen, F
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